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# MAPPING DENGUE RESEARCH OUTPUT

## A STUDY FROM RAWALPINDI MEDICAL UNIVERSITY

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Dengue fever (DF) is the most prevalent arbovirus-related infection globally, with the majority of cases remaining asymptomatic. The clinical spectrum of dengue ranges from a mild febrile illness to more severe manifestations, such as dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS), both of which are associated with significantly higher morbidity and mortality. Identifying early predictors of disease severity is essential for timely clinical intervention.

Current report analyses the 53 research articles (total citations 482) published from 2014 to 2025 on Dengue related research. The report is assessing research output and highlighting any groundbreaking research or gaps identified focusing on Dengue-related research (pathogenesis, epidemiology, diagnostic, prevention, etc.). The 53 research articles were selected from RMU repository, PubMed, Google Scholar, Research gate etc.

## 1. Categorization and Thematic Analysis

53 research articles were organized into key themes or research areas. (Table 1) (Figure 1)

**Table 1:** Research Themes in Dengue Publications (53) by RMU

| Sr. No. | Research area | No. of articles | Key findings |
|---|---|---|---|
| **1** | Epidemiology | **16** | Trends in Dengue spread, risk factors, regional patterns |
| **2** | Pathogenesis | **10** | Virus strains, immune response, molecular mechanisms |
| **3** | Diagnostics | **18** | New detection methods, rapid tests, accuracy studies |
| **4** | Prevention and Control | **08** | Vector control, public health strategies, community awareness |
| **5** | Climate and Environmental Factors | **01** | Impact of climate change on Dengue transmission |
| **6** | Submitted Research Articles | **03** | Trends in Dengue spread, detection accuracy studies |
| **7** | Departmental Reports | **07** | Trends in Dengue spread |

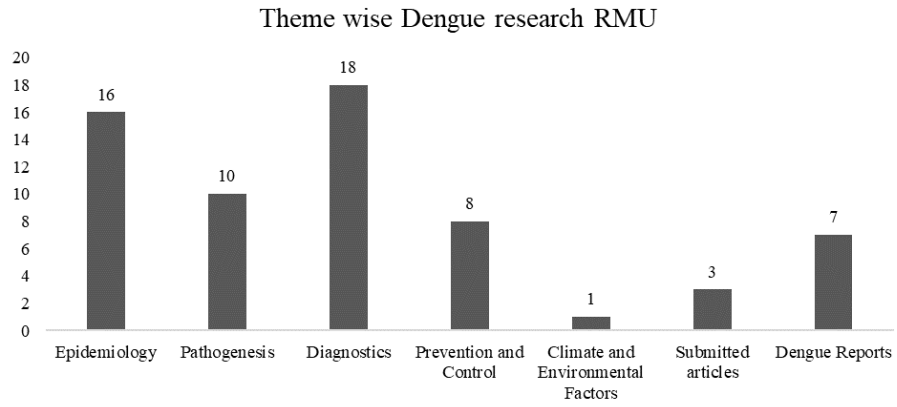


**Figure 1:** Graph of no. of articles in each research area/theme wise distribution.

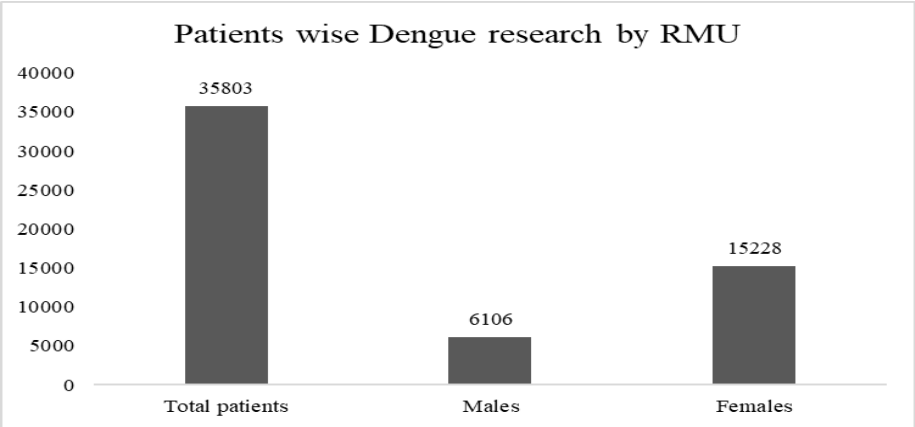


**Figure 2:** Graph of total patients, male and female patients

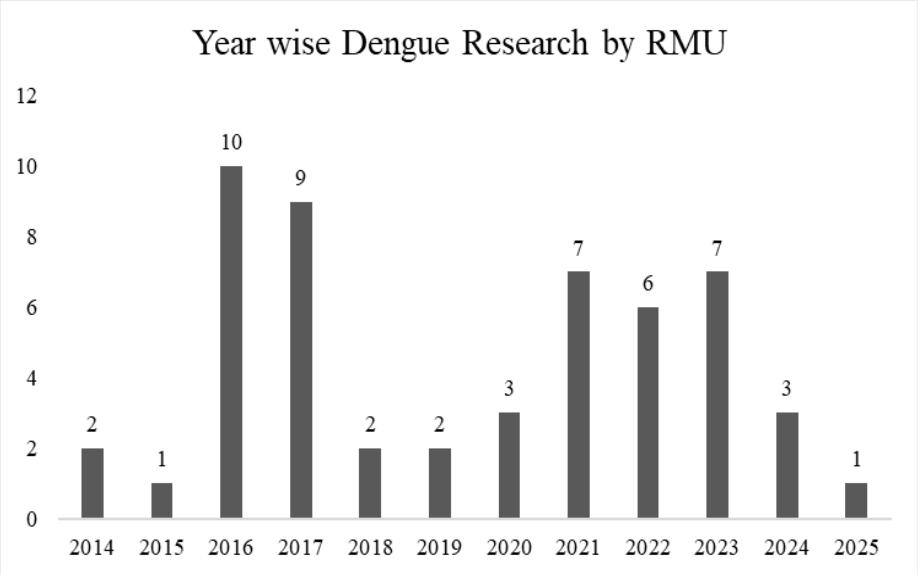


**Figure 3:** Publication trends over time (year wise no. of publication)

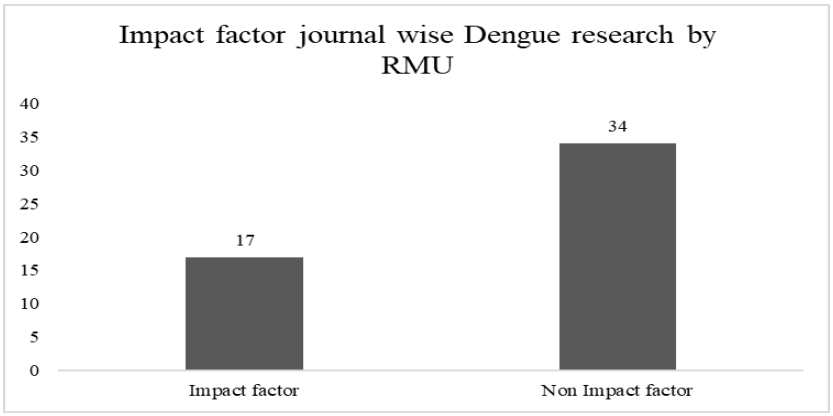


**Figure 4:** Graph of articles published in impact factor and non-impact factor journals

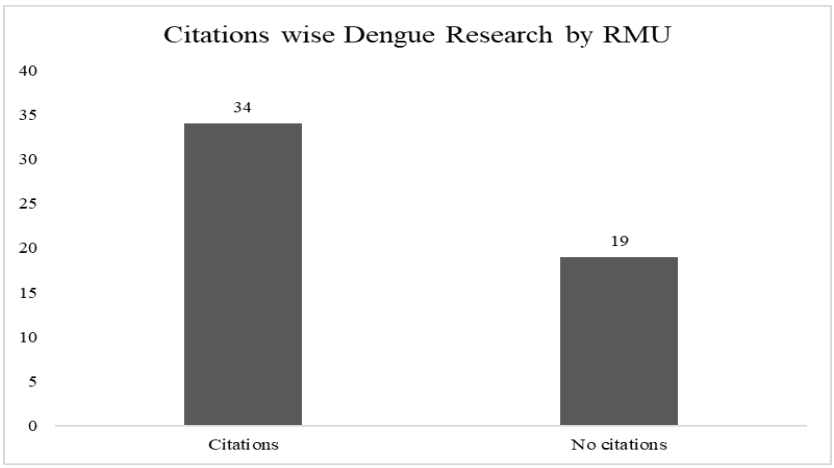


**Figure 5:** Graph of articles with and without citations

## 2. Key Area Analysis (theme/area)

## 2.1. Epidemiology

Most studies on dengue in Pakistan have primarily focused on urban outbreaks, accounting for approximately 70% of the available data, while research from rural areas remains limited. In one study involving 234 patients diagnosed with Dengue Hemorrhagic Fever (DHF), the frequency of primary and secondary dengue infections was assessed, and the two groups were compared based on demographic characteristics, laboratory parameters, disease severity, and clinical outcomes. Among these patients, 66.2% were male and 33.8% were female, with a mean age of 28.8 ± 12.4 years. This analysis aimed to enhance understanding of how the nature of dengue infection—primary or secondary—impacts clinical presentation and prognosis in DHF patients **[1].**

Another observational study was conducted to assess the clinical characteristics, management, and outcomes of patients with Dengue Shock Syndrome (DSS) during the Rawalpindi dengue epidemic of 2014. Data were collected on patient demographics, clinical presentation, laboratory parameters, diagnostic basis, treatment interventions, and outcomes. A total of 25 patients with DSS were enrolled, of whom 52% were male. The mean age of the patients was 26.8 ± 11.52 years. The mean duration of illness prior to hospitalization was 5.4 ± 1.5 days. Commonly reported symptoms included vomiting, body aches, and headache. DSS developed on average by the 5.7 ± 2.04 day of illness. Comorbid

conditions were noted in 24% of the patients. Secondary dengue infection was present in 56% of the cases, while 84% of the patients tested positive for dengue virus serotype DEN-3 by PCR. In summary, young adults infected with DEN-3 were predominantly affected by DSS during the 2014 Rawalpindi dengue epidemic. While secondary dengue infection was observed in more than half the cases, primary infection was also frequently noted. Despite the severity of the condition, the mortality rate remained relatively low at 4%, indicating effective clinical management **[2].**

Another study focused on evaluating the clinical manifestations, disease severity, and outcomes among patients diagnosed with dengue fever (DF), confirmed through serological testing. The objective was to provide a comprehensive analysis of the demographic and clinical features associated with DF, as well as to assess the overall patient outcomes during hospitalization. The study highlighted a clear male predominance among confirmed DF cases, reflecting gender-related vulnerability or exposure patterns during outbreaks. Fever was reported as the most frequent and consistent presenting symptom, aligning with the typical clinical profile of dengue fever. Other associated symptoms varied in frequency but were generally mild, contributing to a low rate of complications in this patient group. The duration of hospitalization was notably short, with patients experiencing a brief mean stay and a limited critical phase. These findings point toward mild to moderate disease severity in the majority of cases. Most patients showed rapid clinical improvement, which was further supported by the high discharge rate observed. The overall outcomes were positive, indicating effective disease management and low morbidity in serologically confirmed cases of DF **[3].**

## 2.2. Pathogenesis

Many articles found the pathophysiology and underlying immunity related mechanism of Dengue patients. One such report presented the first documented case of a young male patient who developed fatal Hemophagocytic lymphohistiocytosis (HLH) complicating a concurrent infection with DHF and *Plasmodium vivax*. This case underscores the importance of considering HLH in the differential diagnosis of patients presenting with severe systemic inflammatory responses in the context of dengue or malaria, particularly when clinical deterioration occurs despite appropriate treatment for the primary infections. Early recognition and prompt intervention are crucial to improving outcomes in such rare but fatal complications **[4].**

Among various laboratory markers, elevated serum alanine aminotransferase (ALT) levels have been proposed as a potential indicator of severe dengue infection. A cross-sectional study was conducted to investigate the relationship between ALT levels at presentation and the progression to severe dengue. Over a six-month period, 65 patients with confirmed dengue infection were enrolled. Serum ALT levels were measured at the time of presentation, and all patients received standardized management according to clinical guidelines. Their clinical course was subsequently monitored for the development of DHF or DSS. Based on these findings, the study concluded that elevated ALT levels at the time of presentation are significantly associated with the development of severe forms of dengue infection. Higher ALT levels may serve as an early warning marker for disease progression, underscoring the importance of closer monitoring and more aggressive management in such patients. These results support the incorporation of liver enzyme evaluation into the routine assessment of dengue patients to aid in risk stratification and improve clinical outcomes **[5].**

A cross-sectional study was conducted to investigate the correlation between polymorphism in the C-reactive protein (CRP) gene and variations in serum CRP levels among dengue patients. The analysis revealed that increased CRP levels were associated with suppressed platelet counts among dengue patients, reflecting the inflammatory response characteristic of the infection. However, the SNP rs199953854 in the CRP gene showed no polymorphism in the sampled population, suggesting that this specific genetic variation does not contribute to the variability in CRP levels among dengue patients in this cohort. The findings highlight the potential of CRP as a biomarker of disease severity but do not support a genetic basis for CRP level variation through the rs199953854 polymorphism in this study population **[6].**

A multi-center study was conducted between 2016 and 2018 to investigate the circulating serotypes of dengue virus (DENV) and the prevalence of Chikungunya virus (CHIKV) co-infection in three major Pakistani cities: Lahore, Rawalpindi, and Peshawar. The study employed both hospital-based cross-sectional surveillance in Lahore and Rawalpindi, and a community-based approach in Peshawar during 2017. The primary objective was to assess the distribution of DENV serotypes and detect co-infections with CHIKV, offering insight into the evolving epidemiology of arboviral diseases in the region. The concurrent circulation of several DENV serotypes alongside CHIKV co-infection represents a significant public health concern. These findings underscore the urgent need for enhanced vector surveillance, diagnostic capacity, and integrated disease management strategies to mitigate the risk of future outbreaks in Pakistan **[7].**

## 2.3. Diagnostics

In an effort to explore the utility of Raman spectroscopy as a non-invasive optical diagnostic tool, a study was conducted to analyze the Raman spectra of human serum samples infected with dengue virus (DENV). Raman spectra were recorded from 32 DENV-infected and 28 healthy serum samples in the near-infrared spectral range (540 to 1700 $cm^{-1}$) using a 785 nm laser as the excitation source. Distinct differences were observed between the spectra of DENV-infected and healthy samples, indicating potential biomolecular alterations associated with dengue infection. The study identified 12 unique Raman spectral bands that differentiated DENV-infected sera from healthy samples. Notably, these bands had not been previously reported in the context of dengue diagnosis. These findings highlight the strong diagnostic potential of the identified Raman bands as biomarkers for dengue virus infection. The study provides a valuable foundation for future research in the field of optical diagnostics and suggests Raman spectroscopy as a promising tool for early and accurate detection of DENV infections **[8].**

An observational retrospective study was conducted at Holy Family Hospital, Rawalpindi, to assess ultrasonographic findings used in diagnosing plasma leakage among patients with dengue haemorrhagic fever (DHF). All included patients underwent ultrasonography to detect signs of plasma leakage, such as ascites, gallbladder wall thickening, and pleural and/or pericardial effusion. These findings were documented in terms of their presence, quantification, and anatomical localization. The most frequently observed ultrasonographic pattern of plasma leakage was a combination of mild ascites and mild right pleural effusion. These results highlight the importance of ultrasonography as a non-invasive, readily available diagnostic tool for identifying plasma leakage in patients with dengue haemorrhagic fever **[9].**

A study aimed to evaluate the effectiveness of Raman spectroscopy as a rapid diagnostic tool for detecting dengue fever in human blood sera, comparing its performance with commonly used serological tests. These findings suggest that Raman spectroscopy shows moderate diagnostic potential, particularly in comparison to IgM antibody testing, and could serve as a rapid screening method for dengue infection. However, its relatively lower sensitivity and accuracy compared to established serological assays indicate that further refinement and validation are necessary before it can be adopted as a standalone diagnostic tool **[10].**

A quantitative method has been developed to screen human serum samples that are positive for immunoglobulin-G (IgG) in cases of dengue virus infection. The regression model was trained using 79 samples, while 20 additional samples were used to assess its performance. The model demonstrated a strong fit, achieving an R-squared ($r^2$) value of 0.91 using a leave-one-out cross-validation approach, indicating its robustness. It captures molecular variations linked to IgG. Analysis of regression coefficients showed that compounds such as myristic acid, coenzyme-A, alanine, arabinose, arginine, vitamin C, carotene, fumarate, galactosamine, glutamate, lactic acid, stearic acid, tryptophan, and vaccenic acid had a positive correlation with IgG levels. Conversely, components like amide III, collagen, proteins, fatty acids, phospholipids, and fucose were negatively correlated. For blind test samples, the model's predictions closely matched clinically measured IgG values. Evaluation metrics—sensitivity (100%), specificity (83.3%), accuracy (95%), and an AUC of 0.99—confirm the model's high reliability [11].

In another investigation, Raman spectroscopy combined with support vector machine (SVM) algorithms was used to classify blood serum samples from suspected dengue patients. This study used spectra from 84 patients collected at Holy Family Hospital in Rawalpindi, Pakistan. Differences between the Raman spectra of dengue-positive and normal samples were analyzed using machine learning techniques. SVM classifiers were built using three different kernel types: Gaussian radial basis function (RBF), polynomial, and linear. Model performance was assessed using 10-fold cross-validation, with the first-order polynomial kernel yielding the best results. Under these conditions, the model achieved approximately 85% diagnostic accuracy, with 90% precision, 73% sensitivity, and 93% specificity [12].

Another study focused on early-stage dengue infection using Raman spectroscopy and a partial least squares (PLS) regression approach. This analysis targeted non-structural protein 1 (NS1), which appears within three days of infection. A total of 39 serum samples were collected and categorized into two groups: a control group (NS1 and antibody negative) and an infected group (NS1 positive, antibody negative). Of these, 29 spectra were used for model development, while 10 were reserved for blind testing. The PLS regression analysis produced a vector of coefficients related to Raman shifts. These identified molecular signatures included cytokines (775–875 $cm^{-1}$), lectins (1003, 1238, 1340, 1449, 1672 $cm^{-1}$), DNA (1040–1140 $cm^{-1}$), and protein alpha/beta structures (933–967 $cm^{-1}$), all relevant to early dengue infection. The model's validity was supported by an R-squared value of 0.891.

Sensitivity, specificity and accuracy were 100% each and the area under the receiver operator characteristic curve was found to be 1 **[13].**

Another study explored the potential of using Raman spectroscopy to screen for dengue virus (DENV) infection in human blood sera by analyzing lactate concentration as a biochemical marker. A total of 70 serum samples were examined, including 50 from confirmed DENV-infected patients and 20 from

healthy volunteers. Raman spectra were recorded over the spectral range of 600 $cm^{-1}$ to 1800 $cm^{-1}$ using a 532 nm laser as the excitation source. The spectral data were analyzed to identify biochemical changes associated with dengue infection. Distinctive Raman peaks were observed in the sera of DENV-infected patients at 750, 830, and 1450 $cm^{-1}$. These peaks are believed to correspond to elevated lactate levels, which are indicative of impaired organ function commonly seen in dengue infection. To validate this observation, controlled additions of lactic acid solution were made to healthy serum samples. The results of this study suggest that lactate levels, as detected by Raman spectroscopy, may serve as a potential biomarker for the diagnosis of DENV infection. This approach offers promising avenues for rapid, non-invasive screening and warrants further investigation for clinical application in dengue diagnostics **[14].**

This study evaluates the use of Raman spectroscopy combined with the random forest (RF) algorithm to analyze dengue fever in human blood serum samples. A total of 100 suspected dengue cases were collected from Holy Family Hospital in Rawalpindi, Pakistan. Of these, 45 were confirmed positive through immunoglobulin M (IgM) capture ELISA tests. To distinguish between infected and healthy samples, a machine learning model was developed that identifies spectral pattern differences and predicts unknown samples based on learned examples. Principal component analysis (PCA) was used to reduce data dimensionality, while RF was employed for classification. To assess the diagnostic performance of this approach compared to the standard IgM ELISA test, sensitivity, specificity, and accuracy were calculated. The RF-based model achieved 91% in all three metrics: sensitivity, specificity, and accuracy [15].

Another study, conducted during a dengue outbreak, investigated gastrointestinal (GI) symptoms in patients hospitalized with the infection. It included 100 patients aged between 13 and 72 years. Data on both common and atypical GI symptoms were collected, and statistical analysis was used to determine the relationship between dengue severity and unusual GI findings. A p-value below 0.05 was considered statistically significant. Among the patients, 58 were male and 42 female. GI symptoms were reported in all cases, with nausea being the most common (89%), followed by abdominal pain (59%) and vomiting (55%). Atypical findings included acalculous cholecystitis (22%), ascites (44%), hepatomegaly (14%), GI bleeding (9%), acute pancreatitis (2%), and severe acute liver injury (5%). These atypical GI symptoms were found to correlate with the severity of dengue infection. The study concludes that GI manifestations are frequent in dengue patients, and individuals with acute fever and unusual abdominal symptoms in endemic areas should be evaluated for dengue [16].

A retrospective study aimed to identify various factors associated with dengue hemorrhagic fever (DHF) and to compare the clinical and laboratory features of DHF with those of dengue fever (DF). The objective was to improve patient evaluation and management at admission. The study was conducted over six years (2013–2018) in two tertiary care hospitals in Pakistan. Data were collected using a pre-structured form and statistically analyzed to determine clinical and laboratory characteristics of dengue virus infection (DVI) and risk factors for the development of DHF. The study demonstrated clear distinctions between the clinical and laboratory profiles of DF and DHF. Significant predictors of DHF included advanced age, diabetes mellitus, ascites, pleural effusion, gallbladder wall thickening, and delayed hospitalization. Early identification of these factors can help clinicians recognize high-risk patients promptly, enabling timely intervention to reduce dengue-related morbidity and mortality **[17].**

## 2.4. Prevention and Control

The articles published by RMU related to prevention and control focused on effectiveness of vitamin D in prevention of dengue haemorrhagic fever and dengue shock syndrome **[18],** comparison of vitamin D levels in patients with dengue haemorrhagic fever and dengue fever **[19],** awareness of Dengue Fever in Non-Medical University Students in Punjab **[20],** seroprevalence of Dengue Among Healthcare Workers: Assessing Infection Risk and Preventive Strategies in a Tertiary Care Hospital **[21],** electrolyte disturbances in patients with dengue fever **[22],** knowledge About Dengue Fever Prevention Among People Visiting Benazir Bhutto Hospital **[23],** awareness of Dengue Fever in Non-Medical University Students in Punjab **[24]** etc.

## 2.5 Climate and Environmental Factors

Only one study on Dengue and Climate and Environmental Factors i.e. Decoding Dengue: A Comprehensive Analysis of Cases at Holy Family Hospital (2019–2023) and Anticipating Pakistan's Future Dengue Dynamics under Climate Change **[25].**

## 2.6. Mortality analysis

Dengue typically has a low mortality rate, with simple dengue fever presenting a mortality of less than 1%, dengue hemorrhagic fever ranging from 2-5%, and dengue shock syndrome carrying a significantly higher mortality of nearly 50%. Rawalpindi Medical University (RMU) affiliated hospitals have achieved an exceptional mortality rate of less than 0.1%, with all recorded fatalities attributed to cases of dengue shock syndrome. Each death underwent thorough review in mortality meetings held at the respective hospitals. Clinical mortality audits were submitted to the Dengue Expert Advisory Group (DEAG) and the Punjab Health Department using the prescribed mortality forms.

In 2019 Dengue Epidemic, highest number of deaths (41) occurred. The reasons were found to be decompensated severe shock at the time of admission, co-morbidities, late arrival to teaching hospitals, pre-hospital treatment from government/private hospitals, resulting in a delay or mismanagement, changing nature of disease due to immunological factors, severe hepatitis which lead to liver failure, multi-organ failure, metabolic acidosis, lactic acidosis and secondary infections **[26].** Mortality rates were notably higher among patients with DHF and DSS compared to those with DF ($p=0.002$), emphasizing the severity of complications associated with these advanced forms of dengue **[27].**

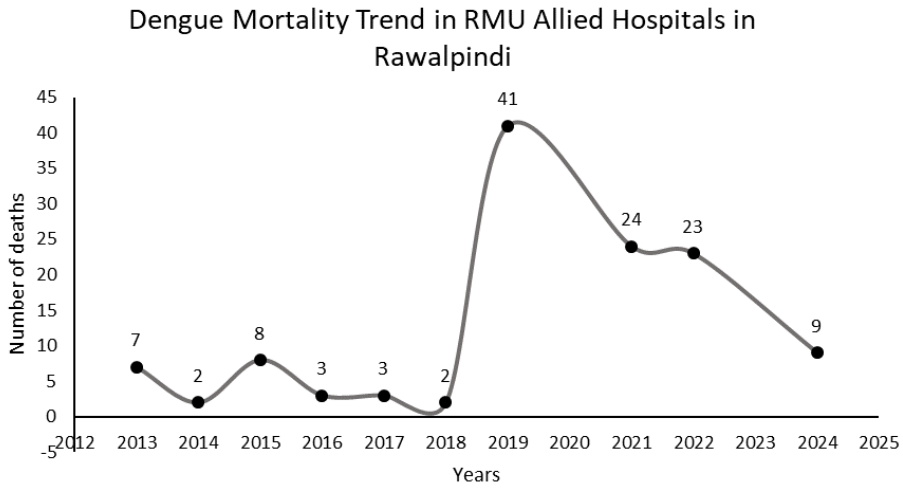


**Figure 6:** Twelve years (2013-2024) comparative mortality trends from RMU-affiliated hospitals
Source: https://rmur.edu.pk/wp-content/uploads/2024/12/denguereport21122024.pdf

According to the report published in 2024 by Rawalpindi Medical University, the mortality was 09 and morbidity was 6528. By 2024, despite a significant increase in case numbers, the mortality rate declined to 0.22%, reflecting advancements in clinical management and treatment strategies.

### 2.7 RMU Dengue Reports analysis

This collection of reports on Dengue has been compiled by the faculty of Rawalpindi Medical University, Rawalpindi as part of an ongoing effort to advance understanding, diagnosis, treatment, and prevention of one of the world's most rapidly spreading mosquito-borne viral diseases. Drawing upon both clinical research and fieldwork, these reports provide valuable insights into the epidemiology, pathophysiology, and public health challenges associated with Dengue. The aim is to contribute to the global body of knowledge while supporting the development of effective medical and community-based responses to this pressing health threat. Since 2015, faculty members has written seven reports on Dengue.

The **Dengue Report (2015)** by the Divisional Dengue Expert Advisory Group (DDEAG), RMU documents the third consecutive dengue epidemic in the region, highlighting a significant increase in cases compared to previous years. The outbreak spanned from August 1 to December 30, with over 44,000 outpatient visits and 6,139 hospital admissions, resulting in 3,917 confirmed cases and 8 deaths. The predominant virus genotype was DEN-2 (61%). DDEAG played a key role in patient management, verification of deaths, and capacity building, training over 1,100 healthcare workers during the season. Despite having no dedicated funding or office, the group contributed to research, published articles, and maintained strong coordination with local health institutions. The report underscores the urgent need for improved preventive measures and highlights the future potential of vaccination efforts in Pakistan **[28].**

The report **Dengue Patient Care and Training Model (2016)** developed by Rawalpindi Medical College and Allied Hospitals outlines a comprehensive, multidisciplinary approach to managing dengue outbreaks, focusing on clinical care, healthcare worker training, and standardized protocols. In 2016, Rawalpindi experienced its fourth consecutive dengue epidemic, with 20,449 outpatient visits,

5,258 admissions, and 3,306 confirmed cases, primarily affected by DEN-2 and DEN-3 genotypes. Despite the widespread impact, the mortality rate was impressively low at 0.09%, attributed to improved prevention, early diagnosis, and structured patient care. The document details the operational framework, including triage systems, HDU/ICU protocols, training programs (over 870 professionals trained that year), and collaboration with Dengue Expert Advisory Group (DEAG) Punjab. The model emphasizes rapid diagnostics, hands-on training, strict monitoring of patients by severity, and real-time data sharing through smart technology, serving as a replicable framework for dengue outbreak preparedness and response **[29].**

The document **Dengue Epidemic (2019)** details the **clinical and operational management** of the 2019 Dengue Epidemic in Rawalpindi and Islamabad, Pakistan, which was identified as the worst year for the epidemic with over 10,000 confirmed cases in Allied Hospitals. The Rawalpindi Medical University and its Allied Hospitals, including Holy Family Hospital, Benazir Bhutto Hospital, and District Headquarters Hospital, along with the newly acquired Red Crescent Hospital, dedicated significant resources such as 1100 beds, a team of over 1300 doctors, nurses, and paramedics, and essential equipment like hematology analyzers and ultrasound machines, to manage the influx of patients. The increased burden was attributed to delayed preventive measures, a new circulating serotype, and low public awareness. The Department of Infectious Diseases played a central role, coordinating with the Punjab Information Technology Board for real-time monitoring and conducting regular training sessions for healthcare worker. The document also highlights the crucial support and coordination from the Government of Punjab, including visits from high-ranking officials and emergency procurement of supplies, and emphasizes that all patient treatment and services were provided free of cost **[26]**.

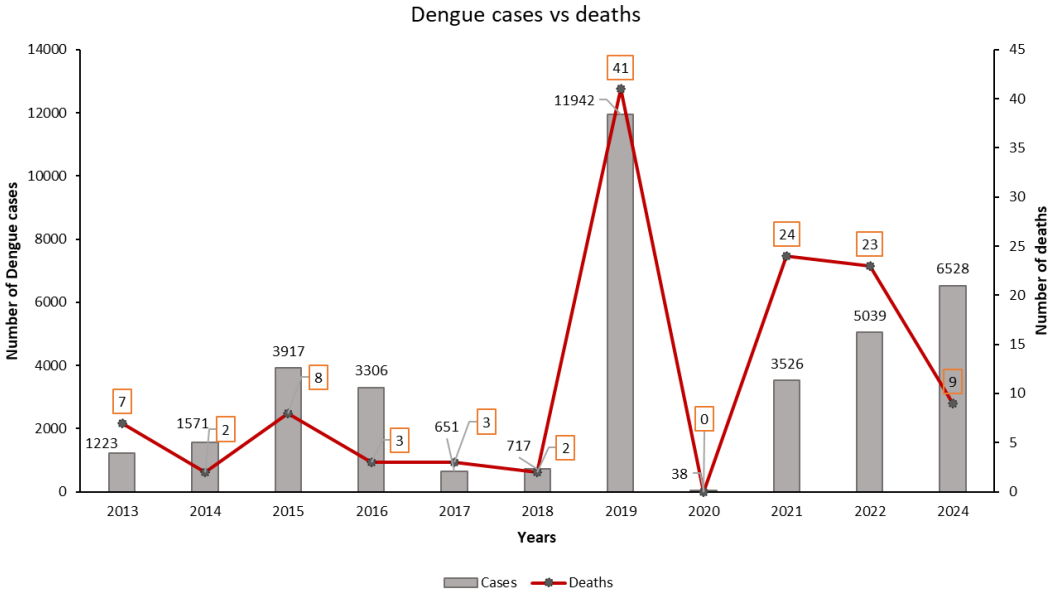


**Figure 7:** Twelve years (2013-2024) comparative Dengue cases vs death trends from RMU-affiliated hospitals

The report **Dengue Epidemic Clinical Management (2020)** details the extensive efforts of Rawalpindi Medical University (RMU) and its Allied Hospitals in managing the 2019 dengue epidemic, which saw 11,941 confirmed cases at RMU Allied Hospitals, making it the worst outbreak since 2015. The report outlines the clinical management strategies, including the phased increase of bed capacity across RMU hospitals and other government/semi-government facilities, the deployment

of additional medical and ancillary staff, and the procurement of necessary medical supplies and equipment. It also highlights the adaptation of Dengue Expert Advisory Group (DEAG) guidelines to include modified treatment protocols for Dengue Shock Syndrome (DSS) patients who did not respond to standard management, which significantly improved patient outcomes. Furthermore, the document emphasizes the importance of prevention over management, detailing efforts in data maintenance, inter-departmental liaison for disease prevention, and continuous training of healthcare workers to enhance capacity for future outbreaks **[30]**.

The **Dengue Epidemic Report (2022)** from Rawalpindi Medical University (RMU) provides a comprehensive overview of the clinical and operational management of dengue fever by the Department of Infectious Diseases at Holy Family Hospital. The 2022 Dengue epidemic in Rawalpindi saw a resurgence close to pre-pandemic levels, striking early in August, with nearly 60,000 symptomatic individuals visiting the OPDs of Rawalpindi Medical University's teaching hospitals. The screening algorithm proved effective, resulting in a low admission rate but a high positivity rate among admitted patients. Approximately 5,039 cases were confirmed, with 23 fatalities, yielding a mortality rate of 0.4%. The epidemic caused significant fiscal and economic losses, though these were not quantified. Data from hospitals (HFH, BBH, DHQ) showed 59,223 OPD visits, 7,059 admissions, 5,039 confirmed cases, 2,031 cases of Dengue Hemorrhagic Fever (DHF), 101 cases of Dengue Shock Syndrome (DSS), and 23 deaths. The report covers the history of dengue epidemics in Pakistan and specifically in Rawalpindi, detailing the 2019 outbreak and the subsequent preparedness and response efforts. It highlights RMU's commitment to managing infectious diseases, including dengue, through a structured approach that encompasses patient care, staff training, and resource allocation, aiming to effectively combat current and future epidemics **[31]**.

The **RMU Model of Data Bank of Dengue, Diabetes and Hepatitis (2023)** outlines the establishment and Standard Operating Procedures (SOPs) for a centralized data bank at Rawalpindi Medical University, aimed at collecting, storing, retrieving, and utilizing patient data for Dengue Fever, Diabetes Mellitus, and Hepatitis. This platform serves healthcare professionals and researchers by providing access to valuable data, guidelines, and best practices to prevent, diagnose, and treat these prevalent diseases. The data bank seeks to enhance understanding, facilitate research, and promote preventive strategies, ultimately addressing the increasing burden of these illnesses. It details procedures for data collection, including patient demographics and clinical parameters, ensures data security and confidentiality through measures like encryption and access controls, and outlines mechanisms for data retrieval and reporting for research and public health initiatives. The document emphasizes the importance of continuous improvement, staff training, and compliance with data protection regulations and ethical guidelines to ensure the data bank's success in improving patient care and public health outcomes **[32]**.

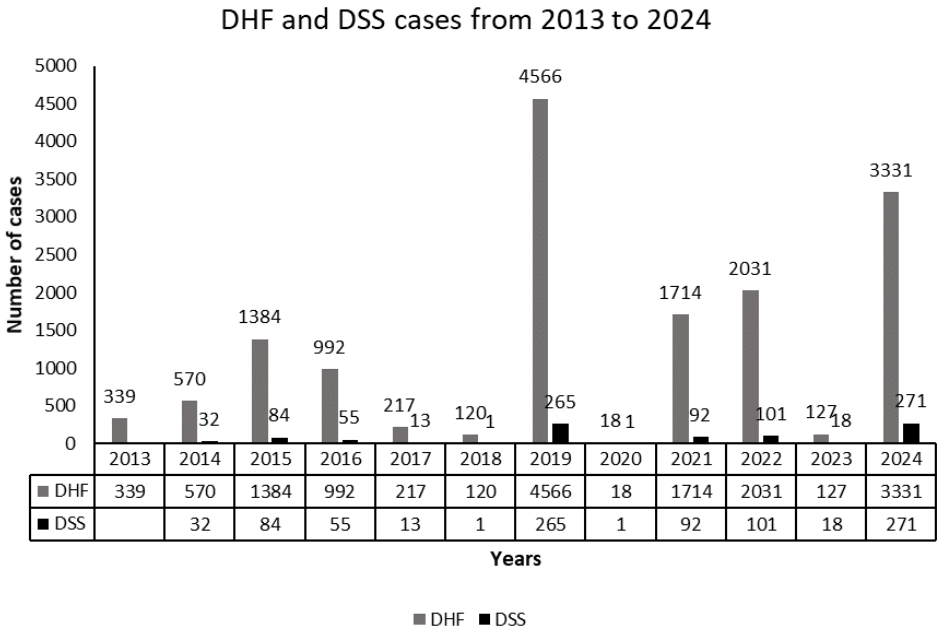


**Figure 8:** Twelve years (2013-2024) comparative DHF and DSS trends from RMU-affiliated hospitals

The **Dengue Epidemic Report (2024)- Patient Care and Operational Optimization** by Rawalpindi Medical University (RMU) provides a comprehensive overview of the dengue fever situation in Rawalpindi, Pakistan, highlighting the significant increase in cases during 2024, which approached pre-pandemic levels. The report details the historical context of dengue epidemics globally and in Pakistan, emphasizing Rawalpindi as a particularly affected region due to factors like urbanization and inadequate sanitation. RMU and its Department of Infectious Diseases have been at the forefront of combating the crisis through surveillance, early diagnosis, treatment, and community awareness campaigns, dedicating 1,000 beds across its allied hospitals for dengue patients and providing training to healthcare professionals. The document also presents comparative data on dengue cases, admissions, and mortality rates from 2013 to 2024, showing fluctuations and the impact of various serotypes and interventions **[27]**.

### 2.8 Twelve-Year Dengue Serotype Trends (2013–2024) at RMU and Allied Hospitals

Over the 12-year period, DENV-2 consistently emerged as the predominant serotype, showing peak prevalence in several years—including 100% in 2013 and 94% in 2021. DENV-3 appeared significantly in 2015, accounting for 85.9% of cases, but has since declined. Interestingly, DENV-1 was detected in 2024 for the first time in this dataset, constituting 90% of reported cases that year.

The data indicates cyclical or evolving trends in serotype dominance, which may correlate with changes in herd immunity, environmental factors, and vector control measures. This comprehensive surveillance is critical for anticipating outbreaks, developing vaccine strategies, and enhancing clinical preparedness based on serotype-specific risks.

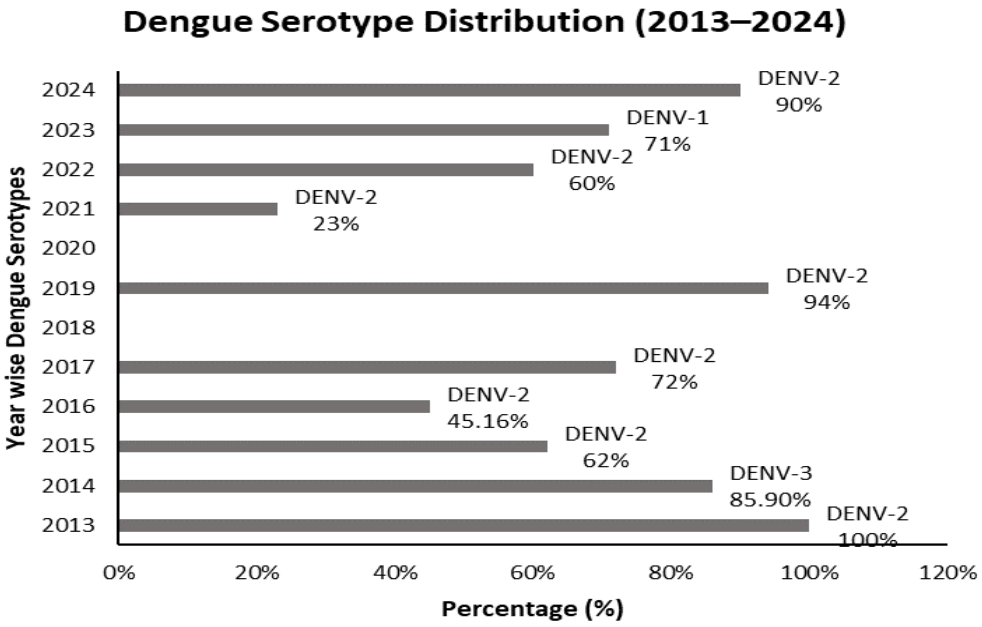


**Figure 9:** Twelve years (2013-2024) comparative Dengue serotype distribution (2013-2024) from RMU-affiliated hospitals

## 2.9 Analysis of submitted research articles

1- Evolving Trends in Dengue Severity and Serotype Dominance: A Decade-Long Analysis in Rawalpindi, Pakistan

Rawalpindi, Pakistan, has experienced recurrent dengue outbreaks over the past decade, with fluctuating intensity, severity, and mortality. Demographic, clinical, and epidemiological trends of dengue cases presented at Rawalpindi Medical University (RMU) and its allied hospitals from 2013 to 2024 were examined, highlighting epidemiological patterns, disease shifts in severity, mortality, and serotype prevalence. This retrospective, descriptive study analyzed 58,625 laboratory-confirmed dengue cases treated at RMU and affiliated hospitals. Data included outpatient visits, admissions, severity patterns (Dengue Fever [DF], Dengue Hemorrhagic Fever [DHF], and Dengue Shock Syndrome [DSS]), mortality rates, and serotype prevalence. Descriptive statistics and comparative analysis (Chi-square, t-tests) were employed to identify trends and statistical associations. The clinical severity of dengue cases escalated over the study period. Dengue hemorrhagic fever (DHF) cases rose from 27.71% in 2013 to 50.01% in 2024 ($p=0.003$). Similarly, dengue shock syndrome (DSS) cases increased from 2.03% in 2013 to 4.10% in 2024, with epidemic years like 2019 showing notable spikes in severe cases. Comparisons among dengue fever (DF), DHF, and DSS incidences revealed statistically significant trends ($p<0.05$), underscoring a consistent increase in disease severity over time. Despite higher admissions in 2024, the case fatality rate (CFR) decreased from 0.34% (2019) to 0.22%. The overall CFR across the study period was 0.26%, with higher mortality observed in DHF and DSS cases compared to DF ($p=0.002$). Predominantly, DENV-2 was the dominant serotype across most years, correlating with increased severity. Shifts in serotype predominance appeared to correlate with increased DHF and DSS severity, though statistical significance was not observed ($p=0.08$). This study demonstrates an upward trend in dengue severity, with DENV-2 dominance correlating with severe disease outcomes. The findings emphasize the need for enhanced vector control, diagnostic

strategies, and molecular surveillance to mitigate outbreaks, guide vaccine development, and improve public health preparedness in endemic regions **[33].**

**2-** Evaluation of Outcome Predictors in Dengue Shock Syndrome: A Comparative Study of Survivors and Non-Survivors during the Epidemic 2024 in Rawalpindi

A prospective cohort study investigates clinical outcomes and identifies key predictors of survival in Dengue Shock Syndrome (DSS) patients at three hospitals in Rawalpindi during the 2024 epidemic. The mortality rate was 26.98% in patients with DSS. Higher WBC count in CBC tests, higher levels of urea and bilirubin in renal function and liver function tests, co-morbidities, admission to MICU, pleural effusion were determined to be the key predictors of DSS outcome and were associated with higher mortality rate whereas factors like ascites showed significant association with improved survival outcome ($p<0.05$). For rest of the variables no significant correlation was found ($P>0.05$). Serological markers, including NS1, IgM, and IgG, also could not significantly predict the outcomes. The identification of seven key predictors of DSS survival underscores the need for targeted management to improve outcomes. Given the limited prognostic value of serological markers, future research should focus on early triage systems and larger multicenter studies to refine treatment protocols in resource-limited settings **[34].**

**3-** Dengue Dynamics: Unraveling Serotype Trends over a Decade at Rawalpindi Medical University

Dengue fever poses a persistent health challenge in Pakistan, marked by cyclic epidemics driven by serotype shifts. A cross-sectional observational study was conducted at Rawalpindi Medical University (RMU) to identify annual predominant Dengue Virus (DENV) serotypes from 2013 to 2024 and shifts in serotype distribution were compared across the study period. From 2013 to 2024, the dengue serotype landscape at RMU was predominantly shaped by DENV-2, which began as the sole serotype in 2013 and maintained its dominance, peaking at 72% in 2017. Notable shifts occurred with DENV-3 taking precedence in 2014 and a co-dominance of DENV-1 and DENV-2 in 2019. By 2023, DENV-1 surged to become the dominant serotype at 71%, only for DENV-2 to reclaim supremacy in 2024 with a striking 90%. While data gaps for certain years limit a comprehensive analysis, the study underscores significant trends: the persistent prevalence of DENV-2, the emergence of DENV-1, and the episodic presence of DENV-3. These findings align with regional dengue patterns, underscoring the interconnected nature of its transmission. The dominance of DENV-2 highlights critical implications for disease severity and targeted public health responses. The RMU data indicates dynamic serotype shifts in dengue virus prevalence over the past decade, emphasizing the need for adaptive surveillance systems. Continuous monitoring and resource allocation adjustments are essential to mitigate potential severe outbreaks linked to serotype changes **[35].**

## Future Horizons

Future research on dengue should focus on a multi-pronged approach to improve early diagnosis, treatment, prevention, outbreak control, diagnosis of emerging Dengue strains and cost-effective diagnostics for low-resource settings. There is a pressing need to identify reliable biomarkers—such as those detected through Raman spectroscopy or genetic profiling—that can differentiate between mild and severe dengue early in the course of illness. Studies on the host immune response, including the role of cytokines and genetic polymorphisms (e.g., in CRP or TNF genes), may uncover critical insights into disease progression and potential therapeutic targets. Additionally, vector surveillance and control strategies should be enhanced through integration of geospatial technologies and artificial

intelligence to predict high-risk areas and outbreaks. The emergence of co-infections with other arboviruses like chikungunya and Zika also necessitates research into differential diagnostics and clinical management. Evaluating the long-term effectiveness and safety of dengue vaccines, especially in different serotype environments, remains crucial. Moreover, community-based awareness and behavioral studies can inform public health interventions to reduce transmission. A collaborative, interdisciplinary approach incorporating clinical, molecular, environmental, and social sciences will be vital in tackling the growing burden of dengue.

## Recommendations:

To strengthen dengue research at RMU, it is recommended that the institution establish a research collaboration between Department of Infectious diseases and Department of Public Health. This should focus on multidisciplinary collaboration, including entomology, virology, epidemiology, and clinical medicine. Emphasis should be placed on conducting longitudinal and community-based studies to track disease patterns, mosquito breeding behaviors, and patient outcomes. The university should also seek national and international research grants, forge partnerships with public health organizations, and invest in modern diagnostic tools and data analytics platforms. Encouraging student-led research and integrating dengue-focused modules into the curriculum will further promote sustained academic interest and innovation in tackling this public health challenge.

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**[3]** *Syed F, Arif MA, Mansoor VB, Usman M, Arif SA. Evolving Spectrum of Dengue: A Two-Year Experience From a Tertiary Care Hospital in Pakistan. Cureus. 2024 Feb;16(2).*

**[4]** *Khurram M, Faheem M, Umar M, Yasin A, Qayyum W, Ashraf A, Zahid Khan J, Hasnain Yasir A, Ansari Y, Asad M, Khan I. Hemophagocytic lymphohistiocytosis complicating dengue and Plasmodium vivax coinfection. Case Reports in Medicine. 2015;2015(1):696842.*

**[5]** *Ayaz F, Furrukh M. Assessment of severity of dengue fever by deranged alanine aminotransferase levels. Cureus. 2020 Sep;12(9).*

**[6]** *Shamshad S, Khan S, Raja GK, Ahmad MS, Asad MJ, Zainab T. Correlation of C-reactive protein levels, gene polymorphism and platelets count in Dengue infection. JPMA. The Journal of the Pakistan Medical Association. 2021 Feb 1;71(2 (A)):429-33.*

**[7]** *Raza FA, Javed H, Khan MM, Ullah O, Fatima A, Zaheer M, Mohsin S, Hasnain S, Khalid R, Salam AA. Dengue and Chikungunya virus co-infection in major metropolitan cities of provinces of Punjab and Khyber Pakhtunkhwa: A multi-center study. PLoS Neglected Tropical Diseases. 2021 Sep 23;15(9):e0009802.*

**[8]** *Amin A, Ghouri N, Ali S, Ahmed M, Saleem M, Qazi J. Identification of new spectral signatures associated with dengue virus infected sera. Journal of Raman Spectroscopy. 2017 May;48(5):705-10.*

**[9]** *Khurram M, Qayyum W, Umar M, Jawad M, Mumtaz S, Khaar HT. Ultrasonographic pattern of plasma leak in dengue haemorrhagic fever. J Pak Med Assoc. 2016 Mar 1;66(3):260-4.*

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**[11]** *Bilal M, Saleem M, Bilal M, Ijaz T, Khan S, Ullah R, Raza A, Khurram M, Akram W, Ahmed M. Raman spectroscopy-based screening of IgM positive and negative sera for dengue virus infection. Laser Physics. 2016 Oct 21;26(11):115602.*

**[12]** *Khan S, Ullah R, Khan A, Wahab N, Bilal M, Ahmed M. Analysis of dengue infection based on Raman spectroscopy and support vector machine (SVM). Biomedical optics express. 2016 Jun 1;7(6):2249-56.*

**[13]** *Bilal M, Bilal M, Saleem M, Khurram M, Khan S, Ullah R, Ali H, Ahmed M, Shahzada S, Khan EU. Raman spectroscopy based investigation of molecular changes associated with an early stage of dengue virus infection. Laser Physics. 2017 Feb 17;27(4):045601.*

**[14]** *Bilal M, Ullah R, Khan S, Ali H, Saleem M, Ahmed M. Lactate based optical screening of dengue virus infection in human sera using Raman spectroscopy. Biomedical optics express. 2017 Feb 1;8(2):1250-6.*

**[15]** *Khan S, Ullah R, Khan A, Sohail A, Wahab N, Bilal M, Ahmed M. Random forest-based evaluation of Raman spectroscopy for dengue fever analysis. Applied spectroscopy. 2017 Sep;71(9):2111-7.*

**[16]** *Hassan M, Ali S, Saleem M, Sanaullah M, Fahad LG, Kim JY, Alquhayz H, Tahir SF. Diagnosis of dengue virus infection using spectroscopic images and deep learning. PeerJ Computer Science. 2022 Jun 1;8:e985*

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**[18]** *Zaman S, Mahmud MR, Khalid MA, Zahid A, Khalid S, Kabir I, Manzoor S, Zaman HZ, Mahmud MR, Khalid MA, Zahid A. Effectiveness of vitamin D in prevention of dengue haemorrhagic fever and dengue shock syndrome. Journal of Rawalpindi Medical College. 2017 Sep 30;21(3).*

**[19]** *Mahmud MR, Zaman S, Naseem N, Iqbal N, Tanveer N, Khalid MA, Mahmud HZ, Zaman S, Naseem N, Iqbal N, Tanveer N. Comparison of vitamin D levels in patients with dengue haemorrhagic fever and dengue fever. Journal of Rawalpindi Medical College. 2018 Jun 30;22(2).*

**[20]** *Ahmed M, Mehmood M, Tahir MJ, Javed H, Ahmed S. Awareness of Dengue Fever in Non-Medical University Students in Punjab. Pakistan Armed Forces Medical Journal. 2022 Apr 30;72(2):440-3.*

**[21]** *Seroprevalence of Dengue Among Healthcare Workers: Assessing Infection Risk and Preventive Strategies in a Tertiary Care Hospital. Seemab Abid, Muhammad Umar, Saima Ambreen, Mujeeb Khan, Mehwish Iqbal, Kekhshan Jabeen & Misbah Nadeem. International Journal of Endorsing Health Science Research*

**[22]** *Sarfraz M, Rabbani A, Manzoor MS, Sarfraz HZ, Rabbani A, Manzoor MS, Zahid H. Electrolyte disturbances in patients with dengue fever. Journal of Rawalpindi Medical College. 2018 Jun 30;22(2).*

**[23]** *Fayyaz T, Yasin M, Tariq A, Mughal A, Bukhari MH, Ms K. Knowledge About Dengue Fever Prevention Among People Visiting Benazir Bhutto Hospital. Journal of Rawalpindi Medical College. 2020 Dec 12;24(1):23-6.*

**[24]** *Ahmed M, Mehmood M, Tahir MJ, Javed H, Ahmed S. Awareness of Dengue Fever in Non-Medical University Students in Punjab. Pakistan Armed Forces Medical Journal. 2022 Apr 30;72(2):440-3.*

**[25]** *Karimi S, Akhtar N, Katiana O, Haider S, Ahmed B, Khan M, Umer M. Decoding Dengue: A Comprehensive Analysis of Cases at Holy Family Hospital (2019–2023) and Anticipating Pakistan's Future Dengue Dynamics under Climate Change. Journal of Islamabad Medical & Dental College. 2024 Jul 20;13(2):345-54.*

**[26]** *Dengue Epidemic 2019, Clinical and Operational Management (https://rmur.edu.pk/wp-content/uploads/2025/02/denfue_book.pdf )*

**[27]** *Dengue report 2024 (https://rmur.edu.pk/wp-content/uploads/2024/11/denguesheet30112024.pdf )*

**[28]** *Divisional Dengue Expert Advisory Group (DDEAG) Rawalpindi: 2015 Report. https://www.researchgate.net/publication/290192109_Divisional_Dengue_Expert_Advisory_Group_DDEAG_Rawalpindi_2015_Report*

**[29]** *Dengue Patient Care and Training Model (2016) (https://rmur.edu.pk/?s=dengue#research)*

**[30]** *Dengue Epidemic Clinical Management 2020 (https://www.researchgate.net/profile/Muhammad-Khurram-7/publication/338501002_Dengue_Epedemic_Clinical_Management/links/5e180d9c92851c8364c0238b/Dengue-Epedemic-Clinical-Management.pdf )*

**[31]** *Dengue Epidemic report 2022 (https://rmur.edu.pk/?s=dengue#research )*

**[32]** *RMU Model of Data Bank 2023 (https://rmur.edu.pk/wp-content/uploads/2025/03/Data-Bank-Log-Bank_VC_SK.pdf)*

**[33]** *Evolving Trends in Dengue Severity and Serotype Dominance: A Decade-Long Analysis in Rawalpindi, Pakistan. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, M Mujeeb Khan, Arshad Rabbani, Shahzad Manzoor, Saima Ambreen*

**[34]** *Evaluation of Outcome Predictors in Dengue Shock Syndrome: A Comparative Study of Survivors and Non-Survivors during the Epidemic 2024 in Rawalpindi. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, Khuzeema Tanveer, Saima Ambreen, M Mujeeb Khan, Malik Shehr yar, Hamza bin Rahat, Somal Sehar, Zainab Ahsan*

**[35]** *Dengue Dynamics: Unraveling Serotype Trends over a Decade at Rawalpindi Medical University. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, M Mujeeb Khan, Arshad Rabbani, Shahzad Manzoor, Saima Ambreen*

# Appendices

**Table 1:** List of Dengue research articles (Title, authors, year, journal, impact factor).

| Sr. No. | Research Article | Year | Journal and IF |
|---|---|---|---|
| 1 | Khurram M, Qayyum W, ul Hassan SJ, Mumtaz S, Bushra HT, Umar M. Dengue hemorrhagic fever: comparison of patients with primary and secondary infections. Journal of infection and public health. 2014 Nov 1;7(6):489-95. | 2014 | Journal of Infection and Public Health (4.7) |
| 2 | Khurram M, Qayyum W, Faheem M, Umar M, Bushra HT, Khan MU, Khan N. Characteristics of dengue shock syndrome during 2014 dengue epidemic in Rawalpindi, Pakistan. Rawal Medical Journal. 1970 Jan 1;41(2):142-. | 2014 | Rawal Medical Journal (0.4) |
| 3 | Khurram M, Faheem M, Umar M, Yasin A, Qayyum W, Ashraf A, Zahid Khan J, Hasnain Yasir A, Ansari Y, Asad M, Khan I. Hemophagocytic lymphohistiocytosis complicating dengue and Plasmodium vivax coinfection. Case Reports in Medicine. 2015; 2015(1):696842. | 2015 | Case Reports in Medicine (0.8) |
| 4 | Khurram M, Qayyum W, Umar M, Jawad M, Mumtaz S, Khaar HT. Ultrasonographic pattern of plasma leak in dengue haemorrhagic fever. J Pak Med Assoc. 2016 Mar 1;66(3):260-4. | 2016 | Journal of the Pakistan Medical Association (0.8) |
| 5 | Khan S, Ullah R, Khurram M, Ali H, Mahmood A, Khan A, Ahmed M. Evaluation of Raman spectroscopy in comparison to commonly performed dengue diagnostic tests. Journal of Biomedical Optics. 2016 Sep 1;21(9):095005-. | 2016 | Journal of Biomedical Optics. (3.0) |
| 6 | Bilal M, Saleem M, Bilal M, Ijaz T, Khan S, Ullah R, Raza A, Khurram M, Akram W, Ahmed M. Raman spectroscopy-based screening of IgM positive and negative sera for dengue virus infection. Laser Physics. 2016 Oct 21;26(11):115602. | 2016 | Laser Physics (1.2) |
| 7 | Khan S, Ullah R, Khan A, Wahab N, Bilal M, Ahmed M. Analysis of dengue infection based on Raman spectroscopy and support vector machine (SVM). Biomedical optics express. 2016 Jun 1;7(6):2249-56. | 2016 | Biomedical optics express (2.9) |
| 8 | Amin A, Ghouri N, Ali S, Ahmed M, Saleem M, Qazi J. Identification of new spectral signatures associated with dengue virus infected sera. Journal of Raman Spectroscopy. 2017 May;48(5):705-10. | 2017 | Journal of Raman Spectroscopy (2.4) |
| 9 | Bilal M, Bilal M, Saleem M, Khurram M, Khan S, Ullah R, Ali H, Ahmed M, Shahzada S, Khan EU. Raman spectroscopy based investigation of molecular changes associated with an early stage of dengue virus infection. Laser Physics. 2017 Feb 17;27(4):045601. | 2017 | Laser Physics (1.2) |
| 10 | Bilal M, Ullah R, Khan S, Ali H, Saleem M, Ahmed M. Lactate based optical screening of dengue virus infection in human sera using Raman spectroscopy. Biomedical optics express. 2017 Feb 1;8(2):1250-6. | 2017 | Biomedical optics express (2.9) |

| | | | |
|---|---|---|---|
| 11 | Khan S, Ullah R, Khan A, Sohail A, Wahab N, Bilal M, Ahmed M. Random forest-based evaluation of Raman spectroscopy for dengue fever analysis. Applied spectroscopy. 2017 Sep;71(9):2111-7. | 2017 | Applied spectroscopy (2.2) |
| 12 | Ayaz F, Furrukh M. Assessment of severity of dengue fever by deranged alanine aminotransferase levels. Cureus. 2020 Sep;12(9). | 2021 | Cureus Journal of Medical Science (1.0) |
| 13 | Shamshad S, Khan S, Raja GK, Ahmad MS, Asad MJ, Zainab T. Correlation of C-reactive protein levels, gene polymorphism and platelets count in Dengue infection. JPMA. The Journal of the Pakistan Medical Association. 2021 Feb 1;71(2 (A)):429-33. | 2021 | The Journal of the Pakistan Medical Association (0.8) |
| 14 | Raza FA, Javed H, Khan MM, Ullah O, Fatima A, Zaheer M, Mohsin S, Hasnain S, Khalid R, Salam AA. Dengue and Chikungunya virus co-infection in major metropolitan cities of provinces of Punjab and Khyber Pakhtunkhwa: A multi-center study. PLoS Neglected Tropical Diseases. 2021 Sep 23;15(9):e0009802. | 2021 | PLoS Neglected Tropical Diseases (3.4) |
| 15 | Hassan M, Ali S, Saleem M, Sanaullah M, Fahad LG, Kim JY, Alquhayz H, Tahir SF. Diagnosis of dengue virus infection using spectroscopic images and deep learning. PeerJ Computer Science. 2022 Jun 1;8:e985. | 2022 | PeerJ Computer Science (3.5) |
| 16 | Syed F, Arif MA, Mansoor VB, Usman M, Arif SA. Evolving Spectrum of Dengue: A Two-Year Experience From a Tertiary Care Hospital in Pakistan. Cureus. 2024 Feb;16(2). | 2024 | Cureus Journal of Medical Science (1.0) |
| 17 | Riaz M, Harun SN, Mallhi TH, Khan YH, Butt MH, Husain A, Khan MM, Khan AH. Evaluation of clinical and laboratory characteristics of dengue viral infection and risk factors of dengue hemorrhagic fever: a multi-center retrospective analysis. BMC Infectious Diseases. 2024 May 17;24(1):500. | 2024 | BMC Infectious Diseases (3.4) |

**Table 2:** Table of Dengue research articles with citations

| Sr. No. | Research Article | Year | Citations |
|---|---|---|---|
| 1 | Khurram M, Qayyum W, ul Hassan SJ, Mumtaz S, Bushra HT, Umar M. Dengue hemorrhagic fever: comparison of patients with primary and secondary infections. Journal of infection and public health. 2014 Nov 1;7(6):489-95. | 2014 | 58 |
| 2 | Khurram M, Qayyum W, Faheem M, Umar M, Bushra HT, Khan MU, Khan N.<br>Characteristics of dengue shock syndrome during 2014 dengue epidemic in Rawalpindi, Pakistan. Rawal Medical Journal. 1970 Jan 1;41(2):142-. | 2014 | 02 |
| 3 | Khurram M, Faheem M, Umar M, Yasin A, Qayyum W, Ashraf A, Zahid Khan J, Hasnain Yasir A, Ansari Y, Asad M, Khan I. Hemophagocytic lymphohistiocytosis complicating dengue and Plasmodium vivax coinfection. Case Reports in Medicine. 2015; 2015(1):696842. | 2015 | 21 |
| 4 | Shams N, Amjad S, Yousaf N, Ahmed W, Seetlani NK, Qaisar N. Predictors of Severity of Dengue Fever in Tertiary Care Hospitals. Journal of Liaquat University of Medical & Health Sciences. 2016 Oct 1;15(4). | 2016 | 06 |
| 5 | Nadeem M, Shafiq MM, Manzoor MS, Ahmed SI. | 2016 | 08 |

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| | Serum ferritin: an indicator of disease severity in patients with dengue infection. JRMC. 2016;20:165-7. | | |
| 6 | Faheem M, Osama M, Khurram M, Khan MM, Ur H, Rehman SA, Anjum N, Hamid S, Umar M. Dengue Fever Induced Fulminant Hepatic Failure. Journal of Rawalpindi Medical College (JRMC). 2016;20(4):331-2. | 2016 | 02 |
| 7 | Khurram M, Faheem M, Masood F, Manzoor S, Khan MM, Masood N, Umar M. Management of adult dengue shock syndrome patients not improving with DEAG guidelines based therapy. Journal of Rawalpindi Medical College. 2016 Mar 30;20(1). | 2016 | 02 |
| 8 | Khurram M, Qayyum W, Umar M, Jawad M, Mumtaz S, Khaar HT. Ultrasonographic pattern of plasma leak in dengue haemorrhagic fever. J Pak Med Assoc. 2016 Mar 1;66(3):260-4. | 2016 | 22 |
| 9 | Khan S, Ullah R, Khurram M, Ali H, Mahmood A, Khan A, Ahmed M. Evaluation of Raman spectroscopy in comparison to commonly performed dengue diagnostic tests. Journal of Biomedical Optics. 2016 Sep 1;21(9):095005-. | 2016 | 19 |
| 10 | Bilal M, Saleem M, Bilal M, Ijaz T, Khan S, Ullah R, Raza A, Khurram M, Akram W, Ahmed M. Raman spectroscopy-based screening of IgM positive and negative sera for dengue virus infection. Laser Physics. 2016 Oct 21;26(11):115602. | 2016 | 11 |
| 11 | Khan S, Ullah R, Khan A, Wahab N, Bilal M, Ahmed M. Analysis of dengue infection based on Raman spectroscopy and support vector machine (SVM). Biomedical optics express. 2016 Jun 1;7(6):2249-56. | 2016 | 133 |
| 12 | Ashfaq MW, Nadeem M, Khalid MA, Shafiq MM, Ahmad SI. Liver biochemistry: difference between dengue fever and non dengue febrile illnesses. JIMDC. 2016;5:10-3. | 2016 | 02 |
| 13 | Zaman S, Mahmud MR, Khalid MA, Zahid A, Khalid S, Kabir I, Manzoor S, Zaman HZ, Mahmud MR, Khalid MA, Zahid A. Effectiveness of vitamin D in prevention of dengue haemorrhagic fever and dengue shock syndrome. Journal of Rawalpindi Medical College. 2017 Sep 30;21(3). | 2017 | 12 |
| 14 | Amin A, Ghouri N, Ali S, Ahmed M, Saleem M, Qazi J. Identification of new spectral signatures associated with dengue virus infected sera. Journal of Raman Spectroscopy. 2017 May;48(5):705-10. | 2017 | 33 |
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| 16 | Bilal M, Ullah R, Khan S, Ali H, Saleem M, Ahmed M. Lactate based optical screening of dengue virus infection in human sera using Raman spectroscopy. Biomedical optics express. 2017 Feb 1;8(2):1250-6. | 2017 | 20 |
| 17 | Khan S, Ullah R, Khan A, Sohail A, Wahab N, Bilal M, Ahmed M. Random forest-based evaluation of Raman spectroscopy for dengue fever analysis. Applied spectroscopy. 2017 Sep;71(9):2111-7. | 2017 | 57 |
| 18 | Mahmud MR, Zaman S, Naseem N, Iqbal N, Tanveer N, Khalid MA, Mahmud HZ, Zaman S, Naseem N, Iqbal N, Tanveer N. Comparison of vitamin D levels in patients with dengue haemorrhagic fever and dengue fever. Journal of Rawalpindi Medical College. 2018 Jun 30;22(2). | 2018 | 03 |
| 19 | Sarfraz M, Rabbani A, Manzoor MS, Sarfraz HZ, Rabbani A, Manzoor MS, Zahid H. Electrolyte disturbances in patients with dengue fever. Journal of Rawalpindi Medical College. 2018 Jun 30;22(2). | 2018 | 03 |
| 20 | Fayyaz T, Yasin M, Tariq A, Mughal A, Bukhari MH, Ms K. Knowledge About Dengue Fever Prevention Among People Visiting Benazir Bhutto Hospital. Journal of Rawalpindi Medical College. 2020 Dec 12;24(1):23-6. | 2020 | 01 |

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| 21 | Ayaz F, Furrukh M. Assessment of severity of dengue fever by deranged alanine aminotransferase levels. Cureus. 2020 Sep;12(9). | 2021 | 02 |
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| 24 | Raza FA, Javed H, Khan MM, Ullah O, Fatima A, Zaheer M, Mohsin S, Hasnain S, Khalid R, Salam AA. Dengue and Chikungunya virus co-infection in major metropolitan cities of provinces of Punjab and Khyber Pakhtunkhwa: A multi-center study. PLoS Neglected Tropical Diseases. 2021 Sep 23;15(9):e0009802. | 2021 | 18 |
| 25 | Malik J, Batool M, Yasmeen T, Manzoor S, Bhatti HW, Mumtaz S. Correlation of serological markers and thombocytopenia in Dengue infection-a cross sectional study from 2019 epidemic in Rawalpindi, Pakistan. The Professional Medical Journal. 2022 May 31;29(06):764-9. | 2022 | 02 |
| 26 | Ahmed M, Mehmood M, Tahir MJ, Javed H, Ahmed S. Awareness of Dengue Fever in Non-Medical University Students in Punjab. Pakistan Armed Forces Medical Journal. 2022 Apr 30;72(2):440-3. | 2022 | 02 |
| 27 | Hussain T, Baloch SK, Adil B, Shaukat M, Rauf F, Khalid MA. Gastrointestinal Manifestations in Adult Patients Presenting with Dengue Infection, A Local Study from Tertiary Care Hospital. Biomedical Journal of Scientific & Technical Research. 2022;42(3):33587-91. | 2022 | 02 |
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| 30 | Malik J, Waheed N, Manzoor S, Mumtaz S, Bhatti HW, Yasmeen T. Association of pattern of thrombocytopenia and serology with timings of plasma leakage in patients of dengue hemorrhagic fever during dengue epidemic 2019–an experience from Rawalpindi Medical University: A cross sectional study. The Professional Medical Journal. 2023 Mar 31;30(04):461-6. | 2023 | 02 |
| 31 | Karimi S, Akhtar N, Katiana O, Haider S, Ahmed B, Khan M, Umer M. Decoding Dengue: A Comprehensive Analysis of Cases at Holy Family Hospital (2019–2023) and Anticipating Pakistan's Future Dengue Dynamics under Climate Change. Journal of Islamabad Medical & Dental College. 2024 Jul 20;13(2):345-54. | 2024 | 02 |
| 32 | Syed F, Arif MA, Mansoor VB, Usman M, Arif SA. Evolving Spectrum of Dengue: A Two-Year Experience From a Tertiary Care Hospital in Pakistan. Cureus. 2024 Feb;16(2). | 2024 | 02 |
| 33 | Riaz M, Harun SN, Mallhi TH, Khan YH, Butt MH, Husain A, Khan MM, Khan AH. Evaluation of clinical and laboratory characteristics of dengue viral infection and risk factors of dengue hemorrhagic fever: a multi-center retrospective analysis. BMC Infectious Diseases. 2024 May 17;24(1):500. | 2024 | 11 |
| 34 | Ultrasound As An Aid To Diagnosis In Dengue. Fatimah Kashif Rasool, Ahmed Kashif Rasool, Lubna Meraj, Farhat Bashir. Journal of Rawalpindi Medical College (JRMC); 2023; 27(1): 208-215. https://doi.org/10.37939/jrmc.v27i1.2148 | 2023 | 1 |
| | Total citations | 482 | |

# Research articles/reports unpublished, RMU

| Sr. No. | Research Articles | Year |
|---|---|---|
| 1 | Evolving Trends in Dengue Severity and Serotype Dominance: A Decade-Long Analysis in Rawalpindi, Pakistan. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, M Mujeeb Khan, Arshad Rabbani, Shahzad Manzoor, Saima Ambreen | 2025 |
| 2 | Evaluation of Outcome Predictors in Dengue Shock Syndrome: A Comparative Study of Survivors and Non-Survivors during the Epidemic 2024 in Rawalpindi. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, Khuzeema Tanveer, Saima Ambreen, M Mujeeb Khan, Malik Shehr yar, Hamza bin Rahat, Somal Sehar, Zainab Ahsan | 2025 |
| 3 | Dengue Dynamics: Unraveling Serotype Trends over a Decade at Rawalpindi Medical University. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, M Mujeeb Khan, Arshad Rabbani, Shahzad Manzoor, Saima Ambreen | 2025 |
| **Sr. No.** | **Reports** | **Year** |
| 1 | Divisional Dengue Expert Advisory Group (DDEAG) Rawalpindi: 2015 Report. https://www.researchgate.net/publication/290192109_Divisional_Dengue_Expert_Advisory_Group_DDEAG_Rawalpindi_2015_Report | 2015 |
| 2 | Dengue Patient Care and Training Model **(**https://rmur.edu.pk/?s=dengue#research**)** | 2016 |
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| 5 | Dengue Epidemic report 2022 **(**https://rmur.edu.pk/?s=dengue#research **)** | 2022 |
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